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# Fire Resistant Fuel Program Update

13 Sep 2011

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# Report Documentation Page

*Form Approved*
*OMB No. 0704-0188*



| 1. REPORT DATE | 2. REPORT TYPE | 3. DATES COVERED |
|---|---|---|
| **01 SEP 2011** | **Briefing Charts** | **01-09-2011 to 01-09-2011** |

| 4. TITLE AND SUBTITLE | 5a. CONTRACT NUMBER |
|---|---|
| **FIRE RESISTANT FUEL PROGRAM UPDATE** | 5b. GRANT NUMBER |
| | 5c. PROGRAM ELEMENT NUMBER |
| 6. AUTHOR(S) | 5d. PROJECT NUMBER |
| **Joel Schmitigal** | 5e. TASK NUMBER |
| | 5f. WORK UNIT NUMBER |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) | 8. PERFORMING ORGANIZATION REPORT NUMBER |
| **U.S. Army TARDEC ,6501 E.11 Mile Rd,Warren,MI,48397-5000** | **#22255** |
| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) | 10. SPONSOR/MONITOR'S ACRONYM(S) |
| **U.S. Army TARDEC, 6501 E.11 Mile Rd, Warren, MI, 48397-5000** | 11. SPONSOR/MONITOR'S REPORT NUMBER(S) |
| | **#22255** |

12. DISTRIBUTION/AVAILABILITY STATEMENT
**Approved for public release; distribution unlimited**

13. SUPPLEMENTARY NOTES
**PRESENTED TO THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA) MEETING**

14. ABSTRACT
**N/A**

15. SUBJECT TERMS

| 16. SECURITY CLASSIFICATION OF: | | | 17. LIMITATION OF ABSTRACT | 18. NUMBER OF PAGES | 19a. NAME OF RESPONSIBLE PERSON |
|---|---|---|---|---|---|
| a. REPORT | b. ABSTRACT | c. THIS PAGE | | | |
| **unclassified** | **unclassified** | **unclassified** | **Same as Report (SAR)** | **17** | |

# Fire Resistant Fuel (FRF) Background

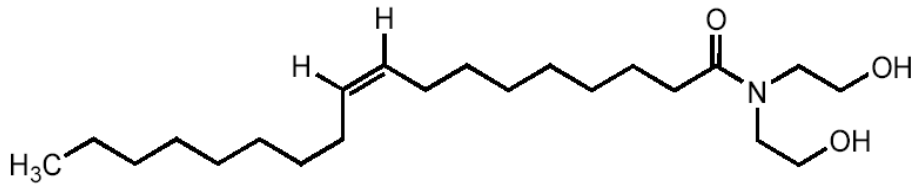
- Fire Resistant Fuel program ran from 1970 -1987
- Diesel 2 fuel used as base stock
  - 52° F Flashpoint
- Program ended due to logistical and operational challenges associated with the water requirements
  - Low temperature usage
  - High water purity requirements
  - 12% additive solution
- IEDs were not a threat

# FRF Development Project

- JP-8 used as battlefield fuel
  - 38° F Flashpoint
- Objectives
  - developing new emulsified fuel formulations;
  - investigating anti-mist additives to diminish the fuel fireball;
  - determining the effect of FRF on vehicle and equipment;
  - designing field blending system for producing the FRF;
  - determining overall effectiveness of the FRF based on JP-8.

# Current FRF Formulation

- FRF formulation:
  - Emulsifier (Schercomid ODA) keeps water in suspension (5-6 vol. %)




Oleamide DEA – a fatty acid amide

  - Schercomid ODA also contains up to 8% of the free oleic acid and up to 25% of the unreacted diethanolamine.

# Current FRF Formulation

- Mist Control Additive (MCA) – (125-250 ppm) reduces initial fireball, essential in JP-8
  - Flo MXC from Baker Petrolite
  - 20-25% polymer in solvent
  - High molecular weight polymers between 5-20 million MW
    - mixture of molecular weights 20 million down to 200,000.
    - majority of the polymers are in the range of 12-16 million MW.
    - shear from blending reduces largest molecules down to 8-10 million molecular weight.
    - Vehicle fuel system shearing causes further reduced down to 4-6 million MW.
  - Additive's tensile strength imparts non-Newtonian properties into fuel, decreasing surface to volume ratio, increasing droplet size which results in reduced fireball size

# Current FRF Formulation

- Water reduces or extinguishes pool fuel fires (10 vol. %)
  - heat sink provided by the water
  - emulsified water on the surface prevents fuel vaporization
  - released water vapor concentrating at the surface of the fuel eliminates oxygen from the fuel

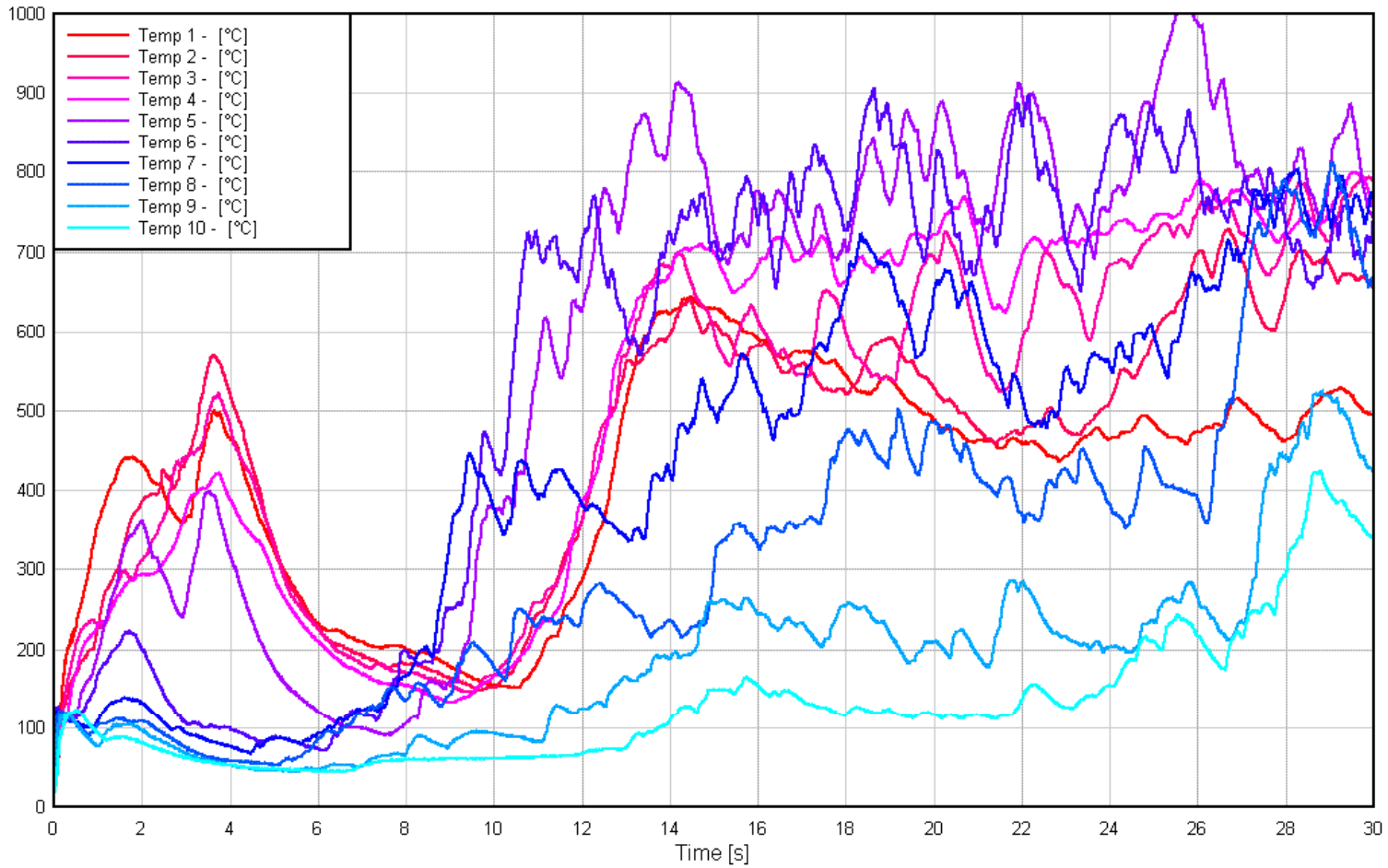
# Sample DF-2 Viscosities

| Sample | Surfactant | Water | MC Polymer | Viscosity |
|---|---|---|---|---|
| 1 | 6% | 10% | 0 ppm | 4.52 CST |
| 2 | 6% | 10% | 125 ppm | 4.83 CST |
| 3 | 6% | 10% | 250 ppm | 5.13 CST |

Kinematic viscosity at 40ºC

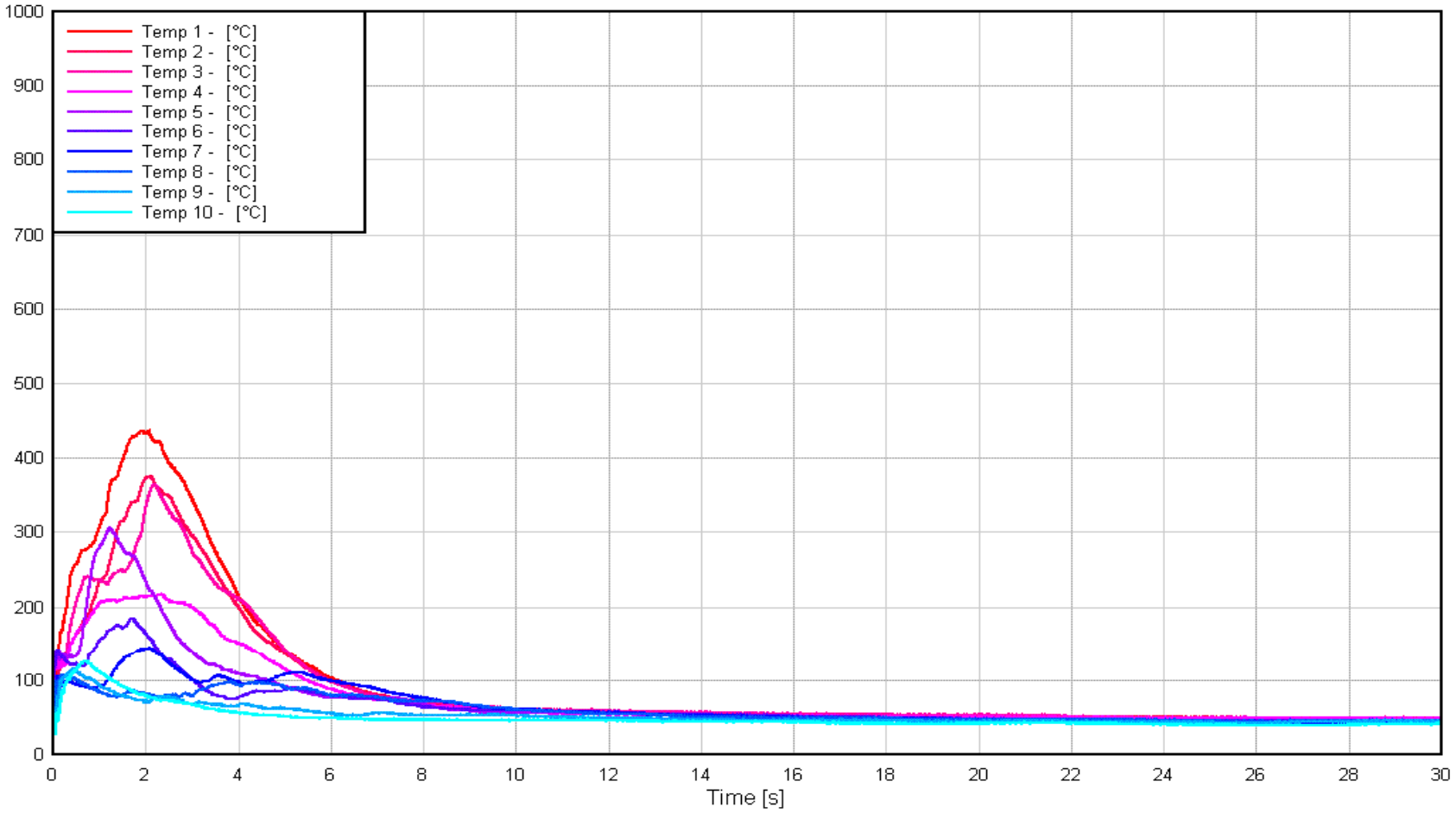
# Fire Resistance

# Fire Resistance Temperature Profile




JP-8 Ballistic Test – Uncontrolled Burn

# Fire Resistance Temperature Profile




(U) Diesel 2 FRF Ballistic Test – Controlled Burn

# Pegasus Vehicle Live Fire

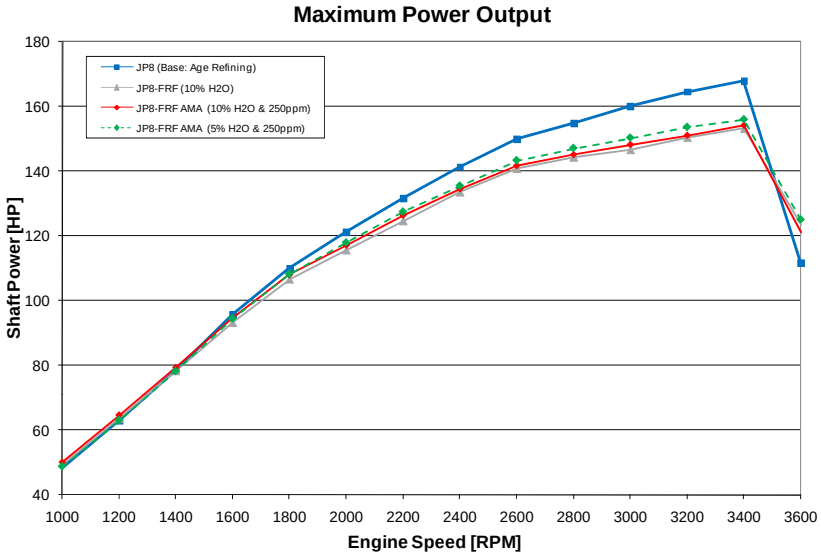
# Pegasus Video

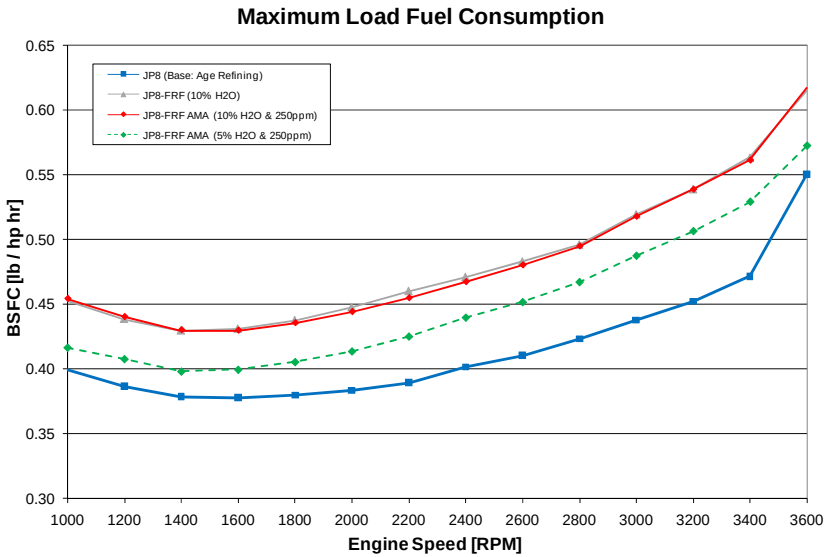
# Mist Control Additive

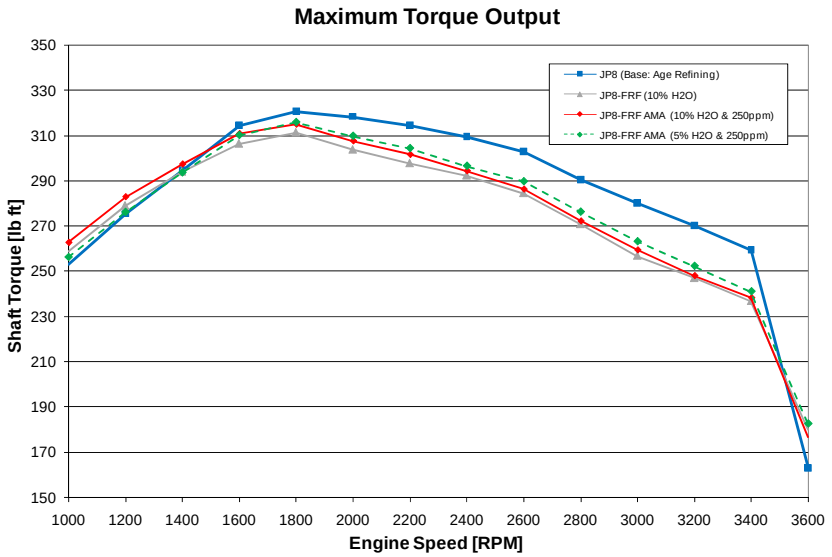
- Mist control “strings”

# Equipment Performance Impacts

- FRF-JP8 fuel reduces power, torque, and fuel economy by 8-9% *(Charts depict 6.5L Turbo Diesel)*



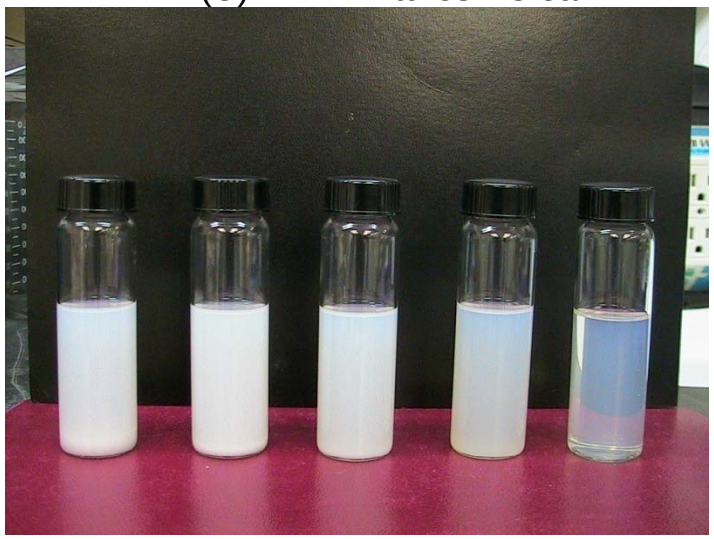
# Up-Armored HMMWV Performance

| | JP8 | JP8 FRF | % change |
|---|---|---|---|
| 0-30 mph (s) | 11.5 | 12.52 | 8.9 |
| 0-50 mph (s) | 32.24 | 37.87 | 17.5 |
| Top Speed (mph) | 67 | 61 | 9.8 |
| Speed on Grade | | | |
| 5% grade (mph) | 40 | 37 | 8.1 |
| 20% grade (mph) | 11 | 10 | 10.0 |
| 40% grade (mph) | 8 | 7 | 14.3 |
| 60% grade (mph) | 5 | 4 | 25.0 |

# Fuel Stability

- Indefinite stability desired
- Stability affected by
  - Temperature
  - Time
  - Agitation

(U) FRF Mixtures - Clear



(U) FRF Mixtures - Cloudy

# FRF field blending concept diagram